Table 12 is a comparison of rainfall intensities, indicated by the various curves which have been used in the design of structures to carry off storm water in the San Francisco Bay region, and also the recorded maximum intensities for the five years during which the tipping-bucket gage has been in operation at Berkeley. The curves are shown by figure 1.

Under some conditions it might be unjustifiable to design a structure for the absolute maximum storm; but if the design is made for a storm of less severity, it is well to know how often the structure is likely to be inadequate. For this reason figure 2 was drawn from the data for all storms in which marked intensities were reached. In order to draw the curves it was necessary to make some interpolations for storms for which the intensity records are incomplete. The curves show within the limits of error imposed by the interpolation and the rather short record (five years) what intensities may be expected in the intervals shown.

551.5[illegible]:551.578.1

## DISTRIBUTION OF CYCLONIC PRECIPITATION.[1]

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[Dated: Physical Institute of College of Science, Tokyo Imperial University, Nov. 20, 1915.]

[Author's abstract.]

The regional distribution of cyclonic rainfall has already been investigated by many meteorologists.[2] The results, however, differ widely according to the localities concerned, and as yet no general theoretical discussion of the principal moments determining the distribution in question seems to have been attempted.

Recently Messrs. T. Yokota and S. Ôtuki, undergraduates in the Physical Institute of the Science College, undertook the statistical investigation of the problem regarding Japan. The chief data used were the daily weather charts of the Central Meteorological Observatory from January, 1905, to December, 1915. The main islands constituting Japan proper, i. e., Kiushu, Shikoku, Honshu, and Hokushu, were divided into 18 districts, 6 each for the Pacific, the Japan Sea, and the axial region. The percentage expectation of precipitation for each of these districts was calculated for different possible positions of the center of a cyclone. The chief results obtained may be summed up as follows:

(1) In front, i. e., on the northeast side of a cyclone, the precipitation is generally more frequent on the Pacific side of the land than on the Japan Sea side. On the rear side of the barometric depression the reverse is the case. The difference is most pronounced in regions remote from the center.

(2) When the center of the depression lies over the Japan Sea far from the land, specially if near the center of curvature of the axial line of Honshu, the lines of equal rainfall expectation have a tendency to run parallel to the axial line. In this case the draining influence of the coastal mountain ranges becomes obvious, in giving birth to a comparatively rainless zone in the axial region of Honshu.

For the case of the center lying over the Pacific, the rainfall is rather concentrated on a limited region of more or less closed shape.

(3) Comparing the depressions lying over the sea but not very far from the coast, the Pacific depression is associated with a more dense and extended precipitation area on the land than the Japan Sea one.

(4) When the depression lies east of Sakhalin the entire Japan Sea coast is affected, and the lines of equal expectation run parallel to the land.

In connection with these investigations a general theoretical discussion of the problem was attempted. It seems convenient to analyze the secondary influences causing the unsymmetrical distribution of cyclonic precipitation into the following three principal moments:

(*a*) Planetary thermal influence, which consists in the change of temperature with latitude. This influence results in shifting the center of rainfall on the southeastern side of the center of depression, in the Northern Hemisphere, provided the other conditions are uniform.

(*b*) Geographical thermal influence, which consists in the thermal contrast between land and water. The results differ widely according to the season, and also according to the humidity of the land in question. For example, in summer in the Northern Hemisphere, provided the land is sufficiently humid, this effect *taken alone* will tend to increase the precipitation on that side of the depression which looked at from the center has the land on the right-hand side.

(*c*) Hydrodynamical topographical influence, which consists in the forced ascending air current brought about by the discontinuity of the horizontal flux of air at the boundary of two regions with different coefficients of friction.[3] According to this influence, the precipitation will be generally abundant, cæteris paribus, on that part of the coast line, or that side of a mountain range, which viewed from the center of a cyclone has the sea or lowlands on the right-hand side. The direction of the greatest rainfall depends on the difference of friction. These relations have been fully discussed in the paper above cited.[3]

These three influences combined properly seem to explain the peculiarities of rainfall distribution in most diverse cases. For example, result (1) above mentioned is the direct outcome of the third influence (*c*). The result (2) may be explained if we consider that the amount of the third influence (*c*) mainly depends on the angle made by the coast line with the radius vector drawn from the center of the cyclone toward the point concerned. Besides, the draining effect of the mountain range may also be interpreted in terms of the same influence, since on the lee side of the range a downward velocity is superposed on the general upward velocity of air proper to the inner region of a cyclone.

Again, result (3) may be elucidated by the combination of influences (*a*) and (*c*), since in our case the supply of the moisture precipitated is mostly from the sea (the

[1] *Terada, Torahiko.* On the distribution of the cyclonic precipitations. (An abstract.) [Read Nov. 20, 1915.] Proc., Tôkyô math.-phys. soc., 1915 (2), 8, no. 12, pp. 382–384. Also separately printed.

[The spelling of place names conforms to the decisions of the U. S. Board on Geographic Names.—C. A. jr.]

[2] *Hildebrandsson, H.* Sur la distribution des éléments météorologiques autour des minimas et des maximas barométriques. Uppsala. 1883.

*Van Bebber* in Meteorol. Ztschr., 1884.

*Åkerblom, Ph.* Sur las distribution à Vienne et à Torshavn des éléments, etc.

*Krankenhagen* in Meteorol. Ztschr., 1885.

*Polis* in Meteorol. Ztschr., 1904.

*Drapczynsky* in Meteorol. Ztschr., 1903.

*Mill, H. R.*, in Symons's met. mag., 1904, 39; Quart. jour., Roy. met. soc., 1908, 36.

*Udden, J. A.*, in Symons's met. mag., 1906, 41.

*Reed, Wm. G.*, in MONTHLY WEATHER REVIEW, Oct., 1911, 39: 1609–16.

*Hann, J.* Lehrbuch der Meteorologie. 3. Aufl., 1915. p. 524, 552.

[3] In the sense of the generalized Guldberg & Mohn theory. See *T. Terada*, in Proc. Tôkyô math.-phys. Soc., 1914, 7.

third influence) and the temperature of the landward wind is generally lower on the Japan Sea side than on the Pacific (the first influence).

Finally, result (4) may also be explained mainly by influence (*c*) if we take account of the stationary character of the Sakhalin depressions and the great extent of the area standing under its influence. As for the second influence (*b*), it would have been conspicuous if the seasonal difference of the precipitation were studied. Moreover, many interesting cases investigated by the earlier authorities seem capable of explanation from the above point of view.

The full details of the above investigations, together with a hint for the mathematical treatment of the problem, is published in the Journal of the College of Science, Tôkyô Imperial University, volume 37, article 4.

## NOTES.

The Royal Hungarian Imperial Institute for Meteorology and Terrestrial Magnetism announces the sudden death of its former director, Ministerialrath Dr. Nikolaus Thege, Edeler von Konkoly, on February 17, 1916, in the seventy-fourth year of his age.

Dr. von Konkoly was the founder of the astrophysical observatory which now bears his name at Ógyalla, Hungary. In 1890 he was appointed director of the Hungarian Imperial Institute for Meteorology, and during his 20 years of service in that institution performed a great and permanent service in perfecting its organization. He was an honorary member of the Hungarian Academy of Sciences, a member of many scientific societies at home and abroad, and the holder of numerous distinguished orders.